AL4 1291
C.2

CANADIANA

NOV 20 1997

1997-98 School Year

Mathematics 30 Information Bulletin

Diploma Examinations Program

Students First! Student Evaluation

Alberta EDUCATION

This document was written primarily for:

Students	✓
Teachers	✓ Mathematics 30 teachers
Administrators	✓
Parents	
General Audience	
Others	

Distribution: Superintendents of Schools • School Principals and Teachers • The Alberta Teachers' Association • Alberta Education • General Public upon Request

Copyright 1997, the Crown in Right of Alberta, as represented by the Minister of Education, Student Evaluation Branch, 11160 Jasper Avenue, Edmonton, Alberta T5K 0L2. All rights reserved. Additional copies may be obtained from the Student Evaluation Branch, 403-427-0010. To call toll-free outside Edmonton, dial 310-0000.

***Alberta educators** may reproduce this bulletin for **educational purposes**.*

This document can be found on our Web pages. Our Internet address is http://ednet.edc.gov.ab.ca.

Contents

Page 1 ***Purpose of the Bulletin***

Page 2 ***Important Dates in the 1997–98 School Year***

Administration of the Mathematics 30 Diploma Examination
Scoring of the Examination

Page 3 ***Notes Of Interest***

Additional Diploma Examination Administrations
Data Resources for Students
Student Use of Scientific Calculators
Student Requests for Rescores
Student Requests for Rewriting
Children in Need of Protective Services
Information for Markers
Examination Development
Inservices and Presentations

Page 7 ***Other Important Documents***

Guide for Students
Examiners' Report
School and Jurisdiction Reports
Annual Reports
General Information Bulletin
Previous Examinations

Page 10 ***Mathematics 30 Information***

Standards
NEW **Examination Design**
Examination Specifications
Mathematics as Communication and Problem Solving
Assessment of Communication and Problem Solving in Mathematics

Page 19 Appendices

Appendix A	**Policy: Use of Scientific Calculators on Alberta Education Diploma Examinations**
Appendix B	**Directing Words**
Appendix C	**Explanation of Mathematical Understandings**
Appendix D	**Looking at Sample Responses**
Appendix E	**Mathematics 30 Curriculum Standards**

Purpose of the Bulletin

The purpose of this bulletin is to provide students and teachers of Mathematics 30 with information about the diploma examinations scheduled for the 1997–98 school year.

This bulletin includes descriptions of the Mathematics 30 diploma examinations, that will be administered in November 1997, January, June, and August of 1998, descriptions of the acceptable standard and the standard of excellence, and subject specific information.

Teachers are encouraged to share the contents of this bulletin with students.

As well, the publication *Students First: A Guide for Students Preparing to Write the Mathematics 30 Diploma Examination* contains significant information for students.

The document entitled *General Information Bulletin, Diploma Examinations Program* (1997–98) provides administrative information about the diploma examinations for the 1997–98 school year.

This bulletin, the *General Information Bulletin*, and the *Students First* guide are distributed to all senior high school principals and are also available on the Internet at Alberta Education's Web site (http://ednet.edc.gov.ab.ca).

If you have questions or comments about the contents of this bulletin, please contact one of the following persons:

Phill Campbell, Assistant Director
Mathematics/Sciences Diploma Examinations
E-mail address: pcampbell@edc.gov.ab.ca

Marion Florence
Mathematics 30 Examination Manager
E-mail address: mflorence@edc.gov.ab.ca

Student Evaluation Branch
Alberta Education
Devonian Building, West Tower
11160 Jasper Avenue
Edmonton, AB T5K 0L2

Telephone: 403-427-0010
Fax: 403-422-4200

To call toll-free from outside of Edmonton, dial 310-0000.

Important Dates in the 1997–98 School Year

Administration of the Mathematics 30 Diploma Examination

The diploma examination is designed for a writing time of 2.5 h. Students must be allowed an additional 0.5 h to complete the examination, if required; therefore, examination supervisors must be available for this additional time.

1997–98 Administrations	*Time*
Thursday, November 6, 1997	9:00–11:30 A.M.
Tuesday, January 27, 1998	9:00–11:30 A.M.
Wednesday, June 24, 1998	9:00–11:30 A.M.
Wednesday, August 12, 1998	9:00–11:30 A.M.

Please consult the *General Information Bulletin, Diploma Examinations Program*, for a complete schedule for all subject areas.

Scoring of the Examination

Scoring of the examination will take place shortly after the administration date.

In early September, the Student Evaluation Branch sends superintendents a letter requesting the names of recommended markers. In this letter, dates for scoring the examination will be announced.

Student Evaluation Branch staff will contact recommended markers before each marking session to confirm participation, and the dates and times for marking.

Notes of Interest

Additional Diploma Examination Administrations

Alberta Education is increasing the number of administrations of diploma examinations to accommodate students' examination needs more effectively. For the 1997–98 school year, in addition to the examinations already offered in January, June, and August, the following diploma examinations will be offered in November and April.

Tuesday, November 4, 1997	9:00–11:30 A.M.	English 30 Part A English 33 Part A
Wednesday, November 5, 1997	9:00–11:00 A.M.	English 30 Part B English 33 Part B
	1:00–3:30 P.M.	Chemistry 30
Thursday, November 6, 1997	9:00–11:30 A.M.	Mathematics 30 Mathematics 33
Monday, April 20, 1998	9:00–11:30 A.M.	Social Studies 30 Social Studies 33
	1:00–3:30 P.M.	Physics 30
Tuesday, April 21, 1998	9:00–11:30 A.M.	Biology 30

The November and April examinations will be available only to students who have school marks in the courses and to individuals having mature student status.

All students must preregister to write diploma examinations in November and April; walk-ins will not be allowed. Students should contact their school principal for application forms and for the location of the nearest writing centre. The application deadlines for the November and April writings are October 10, 1997, and March 26, 1998, respectively.

Data Resources for Students

There is a tear-out formula sheet and a z-score page provided in all 1997–98 Mathematics 30 diploma examinations.

Student Use of Scientific Calculators

Examinations are constructed to ensure that the use of particular scientific calculators neither advantages nor disadvantages individual students. Students are expected to provide their own scientific calculators.

Refer to Appendix A for the policy statement on the use of scientific calculators on diploma examinations. Students should be made aware of this policy as early as possible in the school term to ensure they are able to use the scientific calculator of their choice when writing examinations. It is important to clarify with students exactly what they are allowed to have stored in their calculator memories.

Students should also be made aware of the Examination Rules, Grade 12 Diploma Examinations (see the *General Information Bulletin*).

Student Requests for Rescores

Students may request a rescoring of their diploma examinations. Before applying for a rescoring, students should check their *Diploma Examination Results Statement* to find out the distribution of marks. The mark on the machine-scored questions is not likely to change as a result of a rescore, but the written-response mark could change slightly. Students should remember that the rescored mark will be the final mark whether it *increases* or *decreases*.

Students who decide to have an examination rescored must ensure that their application is received before the deadline specified on the results statement. The fee for rescoring each examination is $26.75, which includes GST. If a diploma examination mark is increased by 5% or more as a result of rescoring, the fee is refunded.

Student Requests for Rewriting

Students may rewrite a diploma examination in any regularly scheduled administration. The fee for rewriting each examination is $26.75, which includes GST. Please note that this rewrite fee applies to students repeating the course as well as to those who choose to write the examination. Students must apply to the Student Evaluation Branch by the following dates to be eligible to rewrite the diploma examinations.

Examination Administration	Rewrite Request Deadline
November 1997	October 10, 1997
January 1998	November 14, 1997
June 1998	April 29, 1998

(For more details, see the *General Information Bulletin*.)

Children in Need of Protective Services

If a student who is under 18 years of age indicates in his or her writing that he or she is a victim of physical or sexual abuse, the markers are required *by law* to refer the paper to Social Services. Social Services is required to investigate situations that suggest that children might require protection.

Information for Markers

The written-response questions of the Mathematics 30 Diploma Examinations are marked by Mathematics 30 teachers selected from those who have been recommended as markers to the Student Evaluation Branch by their superintendents.

Qualifications

To qualify for recommendation, a teacher must have taught the complete Mathematics 30 course for two or more years (or four semesters) prior to the current school year, be teaching the course in the current school year, and have an Alberta or Northwest Territories Permanent Professional Teaching Certificate.

Dates for Recommendation

Teachers who wish to be recommended as markers for the diploma examinations should contact their superintendents by the following dates.

Diploma Date	Contact Superintendent by
January 1998	October 01, 1997
June & August 1998	March 01, 1998

Markers for the November and April examinations will be selected from lists of prospective markers submitted by their respective school superintendents.

Criteria for Selection

More teachers are recommended as markers by superintendents than are required by the Student Evaluation Branch for any one marking session. The following criteria are considered when markers are selected for a particular marking session:

- experience as a marker (experienced markers and first-time markers are included)
- regional representation (by zone, jurisdiction, and school)
- student population (proportional representation)

We particularly need teachers who can mark examinations written in French.

Examination Development

As the need arises for teachers to participate in field testing and item writing, letters are sent to superintendents requesting their nominations. Item writing takes place throughout the year and is a vital component of the diploma exam program. Field testing provides students and teachers with the opportunity to become familiar with the nature of questions they will encounter on future diploma exams. Only teachers who have been nominated by their superintendents are eligible to participate in these activities. Therefore, it is essential that teachers who are interested in these activities should contact their superintendents.

Inservices and Presentations

On a limited basis and subject to budget constraints, Student Evaluation Branch staff may be available to provide inservices or presentations related to diploma examinations or the interpretation of diploma examination results.

Other Important Documents

Guide for Students

A publication written for students called *Students First: A Guide for Students Preparing to Write the Mathematics 30 Diploma Examination* is available in each senior high school and on Alberta Education's Web site (http://ednet.edc.gov.ab.ca). This publication contains suggestions for exam preparation and exam writing suggestions. The Student Evaluation Branch highly recommends that students and teachers examine this document early in the term to prepare for the Mathematics 30 Examination. Parents will also find this to be a useful publication.

Examiners' Reports

Following the administration of each January and June diploma examination, the Student Evaluation Branch sends copies of the *Mathematics 30 Examiners' Report* to all senior high schools in Alberta, and also posts it on Alberta Education's Web site (http://ednet.edc.gov.ab.ca).

The *Examiners' Report* contains

- detailed provincial results
- examiners' comments about student performance on the exam
- a detailed blueprint of the examination by reporting category
- the key and difficulty level for all the questions on the examination
- sample questions accompanied by commentary

The *Examiners' Report* provides important information for teachers who wish to interpret their students' results in relationship to provincial results as an ongoing form of program evaluation.

School and Jurisdiction Reports

School and Jurisdiction Statistical Reports are made available to schools and school jurisdictions after each January and June administration of the diploma examinations. These reports are placed on the Dial-In Facility of the Educational Information Exchange and provide detailed information on how well the students in their school and school district, respectively, did on each of the diploma examinations. Teachers may use these data to reflect on the areas of the program where their students did well and those areas where student performance was poor.

Annual Reports

Each year, the Student Evaluation Branch produces the *Annual Report, Diploma Examinations Program*. This report contains information about the results achieved by all students who wrote diploma examinations in the preceding school year. It also contains special studies on topics of interest.

Each of these special studies will be of interest to teachers who are involved in interpreting the diploma examinations results of their students.

Diploma Examinations Program

Year	Special Studies Topic
1989–90	Comparing Achievement in Various Diploma Examination Courses
1990–91	Different Paths to Success in Diploma Examination Courses
1991–92	Participation Rates in Diploma Examinations Courses
1992–93	Conventions of Language
1993–94	Participation Rates Over Time
1994–95	Grade 12 Enrollment Decline—A Preliminary Assessment
1995–96	Differential Item Performance Between Males and Females on the June 1996 Administration of the Social Studies 30 Diploma Examination

The 1995–96 Annual Report is available on the Internet at Alberta Education's Web site (http://ednet.edc.gov.ab.ca).

General Information Bulletin

Each September, the Student Evaluation Branch sends all senior high school principals and superintendents copies of the *General Information Bulletin, Diploma Examinations Program*, and also posts it on Alberta Education's Web site (http://ednet.edc.gov.ab.ca). This bulletin provides the information, dates, policies, and rules that apply to the administration of all diploma examinations for the school year.

Teachers and students who have questions about such issues as partial writings, word-processor policy details, special provisions for learning and/or physically disabled students writing diploma exams, dates for exam administration, and definitions of mature students, should consult this bulletin.

Previous Examinations

Previous Mathematics 30 January and June diploma examinations are posted on the Alberta Education's Web site (http://ednet.edc.gov.ab.ca) and are also available for purchase (@$4.00 + G.S.T.) from the

Learning Resources Distributing Centre
12360-142 Street, Edmonton, AB T5L 4X9
Phone: 403-427-5775 (toll-free 310-0000) Fax: 403-422-9750

Teachers and students who are consulting previous exams should use exams administered under the present *Program of Studies*.

Mathematics 30 Information

Standards

Provincial standards help to communicate how well students need to perform to be judged as having achieved the learnings specified for Mathematics 30. According to the *Mathematics 30 Course of Studies*, student learnings refer to specific knowledge, skill, and attitude expectations. These learnings are amplified in Appendix E, Mathematics 30 Curriculum Standards, of this bulletin. Also included in Appendix E are examples of questions that students must be able to answer to demonstrate *acceptable* or *excellent* achievement. The examples provided are by no means exhaustive: they are intended to provide a profile of *acceptable* and *excellent* achievement.

Students who demonstrate *acceptable* achievement but not *excellent* achievement in Mathematics 30 will receive a final course mark between and including 50% and 79%. Typically, these students have gained new skills and knowledge in mathematics but can anticipate difficulties if they choose to enroll in post-secondary mathematics courses. They have demonstrated mathematical skills and knowledge in the seven content strands of the Mathematics 30 curriculum and exhibit an ability to apply a broad range of problem-solving skills to these content strands.

Students who demonstrate *excellent* achievement will receive a final course mark of 80% or higher. Such students have demonstrated their ability and interest in mathematics and feel confident about their mathematical abilities. These students should encounter little difficulty in post-secondary mathematics programs; they should be encouraged to pursue careers in which they will use their talents in mathematics.

The specific statements of standards in Appendix E were written primarily to inform Mathematics 30 teachers about the extent to which students must know the Mathematics 30 content and must demonstrate the required skills to pass the examination.

Examination Design

The design of the Mathematics 30 diploma examinations in the 1997–98 school year is as follows:

Question Format	*Number of Questions*	*Percent Emphasis*
Multiple-Choice	40	57
Numerical-Response	9	13
Written-Response	3	30

The 1997–98 examinations consist of a multiple-choice and numerical-response section and a written-response section.

The numerical-response questions are dispersed throughout the multiple-choice questions, placed according to content topic.

NEW

Information required to answer multiple-choice or numerical-response questions is often located in a box preceding the question. On occasion, the information given in the box may be required to answer more than one question. The number of questions that require the use of the information given in the box will be clearly stated above the box; e.g., "*Use the following information to answer the next two questions.*"

Multiple Choice and Numerical Response

For multiple-choice questions, students are to choose the correct or best possible answer from four alternatives.

For numerical-response questions, students are to calculate a numerical answer. As well, students are to record their answer in a separate area of the answer sheet. When the answer students are to record is not a decimal value (e.g., the number of people or the degree of a polynomial), students are asked to determine what "the number of people is _____" or what "the degree of this polynomial is _____." If the answer can be a decimal value, then students are asked to record their answer correct to the nearest tenth or nearest hundredth.

NEW

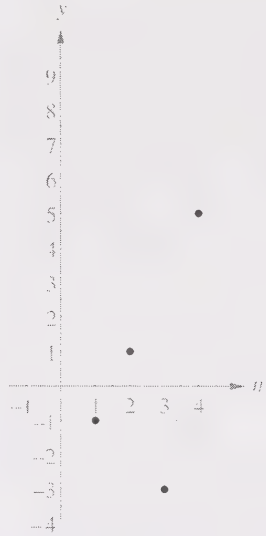
Numerical-response questions may not require students to actually calculate a numerical answer from a problem, but may ask students to record their understanding of a conceptual idea. The following is an example of such a question.

Use the following information to answer the next question.

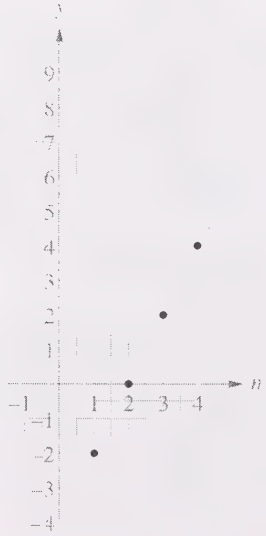
Four graphs, numbered 1 to 4 inclusive, are shown below.
Each point $P(a, b)$ satisfies the condition $a \in N,\ b \in \mathrm{I}$.

Graph 1

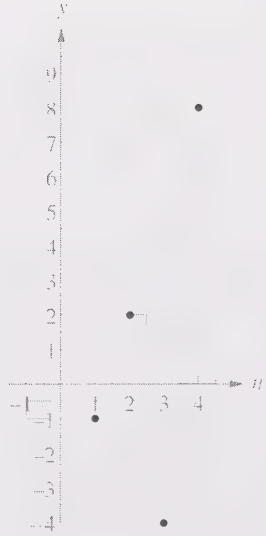
Graph 2



Graph 3



Graph 4



Numerical Response

2. Each of the statements below describes one of the graphs numbered 1 to 4. Match each statement to the graph it describes.

Statement

A Each point on the graph is in the form (n, t_n) where t_n, $1 \le n \le 4$, is an **arithmetic sequence**. _____ (Record in column 1 on the answer sheet)

B Each point on the graph is in the form (n, S_n) where S_n is the **sum** of the **arithmetic sequence** in statement ***A***. _____ (Record in column 2 on the answer sheet)

C Each point on the graph is in the form (n, t_n) where t_n, $1 \le n \le 4$, forms a **geometric sequence**. _____ (Record in column 3 on the answer sheet)

D Each point on the graph is in the form (n, S_n) where S_n is the **sum** of the **geometric sequence** in statement ***C***. _____ (Record in column 4 on the answer sheet)

Answer: 3142

Written Response

The written-response section focuses on students' understanding of the process of solving a problem and encourages students to take risks to arrive at a solution. Students will be rewarded for selecting a problem-solving strategy and for carrying through with the strategy to find a solution. To achieve *excellence*, students must be able to select a strategy, carry it through, and complete the problem. The written-response section of the examination also focuses on students' understanding of mathematical concepts and allows for the most flexibility in gaining an understanding of students' communication and problem-solving abilities in mathematics.

Questions in the written-response section ask students to solve, explain their solution, justify their solution, or prove. For a definition of directing words that students may encounter on the diploma examination, see Appendix B.

In scoring the written-response section of the examinations, markers will evaluate how well students

- understand the problem or the mathematical concept
- correctly use the mathematics
- use problem-solving strategies and explain their answer and procedures
- communicate their solutions and mathematical ideas

Above all, students should be encouraged to try to solve the problem. Even an attempt at a solution could be worth some marks. If students leave the paper blank, markers will not be able to award any marks. The three written-response questions are each scored on a five-mark scoring rubric. Samples of responses to written-response questions on the January 1997 examinations, and how they were scored, are presented in Appendix D.

NEW

Since 1996 the symbol used for real numbers has been $\mathfrak{R}$. This symbol has been used both on field tests and diplomas. There are actually 3 symbols that may be used, i.e., R, Re, or $\mathfrak{R}$ (Mathematics Dictionary by James and James).

Examination Specifications

Each Mathematics 30 Diploma Examination is designed to reflect the core content outlined in the *Mathematics 30 Course of Studies*. The examination is limited to those expectations that can be measured by a paper-and-pencil test. The time allotted to write the examination is two and one-half hours. Students may take an additional one-half hour to complete the examination.

The content for the Mathematics 30 diploma examinations in the 1997–98 school year is emphasized as follows:

Machine-Scored Content[1]	*Percent Emphasis*
Polynomial Functions	11
Trigonometric and Circular Functions	12
Statistics	5
Quadratic Relations	10
Exponential and Logarithmic Functions	11
Permutations and Combinations	10
Sequences and Series	11
Total Multiple-Choice and Numerical-Response Question	70
Written-Response	30

As explained in the 1994 to 1996 Mathematics 30 Diploma Examination information bulletins, the written-response questions will assess whether or not students can draw on their mathematical experiences to solve problems and to explain mathematical concepts. Therefore, the written-response questions will not necessarily fall into a particular unit of study but may cross more than one unit or may require students to make the connections between mathematical concepts.

Note: There are three written-response questions on the Mathematics 30 Diploma Examination. Each question is worth 10% of the entire examination. A sample of a general five-point scoring rubric is found in Appendix D of this bulletin.

The three mathematical understandings of procedures, concepts, and problem solving are addressed throughout the examination. Each understanding has the following emphasis:

Multiple-Choice and Numerical-Response	*Percent Emphasis*
Procedures	21
Concepts	24.5
Problem Solving	24.5
Written-Response	
Procedures, Concepts, Problem Solving	30

[1]Content descriptions have been shortened in this table.

Each examination is built as closely as possible to these specifications.

Since the machine-scorable and written-response questions are weighted components, to calculate a student's examination mark, do the following calculation:

$$\left(\frac{x}{49} \times 70\right) + \left(\frac{y}{15} \times 30\right) = \text{exam mark}$$

x: Student total score on multiple-choice and numerical-response questions
y: Student total score on written-response questions

Mathematics as Communication and Problem Solving

Communication

In keeping with the expectations listed in the *Mathematics 30 Course of Studies*, the 1997–98 examinations will reflect mathematics as communication. The program of studies includes communication in the problem-solving expectations: "Students will be expected . . . to read the problem thoroughly; identify and clarify key components; restate the problem, using familiar terms . . . ask relevant questions . . . document the solution process . . . and explain the solution in oral or written form . . . ."
(From *Mathematics 30 Course of Studies*, pp. 6–7)

These expectations are consistent with the recommendations made by the National Council of Teachers of Mathematics:

> In grades 9 to 12, the mathematics curriculum should include the continued development of language and symbolism to communicate mathematical ideas so that all students can
>
> - reflect upon and clarify their thinking about mathematical ideas and relationships
> - formulate mathematical definitions and express generalizations discovered through investigations
> - express mathematical ideas orally and in writing
> - read written presentations of mathematics with understanding
> - ask clarifying and extending questions related to mathematics they have read or heard about
> - appreciate the economy, power, and elegance of mathematical notation and its role in the development of mathematical ideas
>
> Focus: All students need extensive experience listening to, reading about, writing about, speaking about, reflecting on, and demonstrating mathematical ideas.
>
> (From *Curriculum and Evaluation Standards for School Mathematics*, National Council of Teachers of Mathematics, 1989, p. 140)

The National Council of Teachers of Mathematics describes the evaluation of mathematics as communication in the following manner:

> The assessment of students' ability to communicate mathematics should provide evidence that they can
>
> - express mathematical ideas by speaking, writing, demonstrating, and depicting them visually
> - understand, interpret, and evaluate mathematical ideas that are presented in written, oral, or visual forms
> - use mathematical vocabulary, notation, and structure to represent ideas, describe relationships, and model situations
>
> (From *Curriculum and Evaluation Standards for School Mathematics*, National Council of Teachers of Mathematics, 1989, p. 214)

Besides writing to communicate results, the accuracy of and logic in students' mathematical statements also reflects mathematics as communication. Hence, students will continue to be expected to demonstrate logical and meaningful communication on the diploma examinations.

Problem Solving

In keeping with the expectations identified in the *Mathematics 30 Course of Studies*, the 1997–98 examinations will reflect mathematics as problem solving. Problem solving is integrated throughout the content areas in the curriculum. A set of specific problem-solving learner expectations precedes the specific content learner expectations.

The expectations contained in the program of studies are consistent with the recommendations made by the National Council of Teachers of Mathematics:

> In grades 9 to 12, the mathematics curriculum should include the refinement and extension of methods of mathematical problem solving so that all students can
>
> - use, with increasing confidence, problem-solving approaches to investigate and understand mathematical content
> - apply integrated mathematical problem-solving strategies to solve problems from within and outside mathematics
> - recognize and formulate problems from situations within and outside mathematics
> - apply the process of mathematical modeling to real-world problem situations

Focus: In grades 9 to 12, the problem-solving strategies learned in earlier grades should have become increasingly internalized and integrated to form a broad basis for the student's approach to doing mathematics, regardless of the topic at hand. From this perspective, problem solving is much more than applying specific techniques to the solution of classes of word problems. It is a process by which the fabric of mathematics as identified in later standards is both constructed and reinforced.

(From *Curriculum and Evaluation Standards for School Mathematics*, National Council of Teachers of Mathematics, 1989, p. 137)

Assessment of Communication and Problem Solving in Mathematics

The open-ended question provides a way in which to examine mathematics as communication and mathematics as problem solving. An open-ended question allows students to communicate a response by asking them to explain their reasoning, explain their solution, describe mathematical situations, write directions, create new problems, create new strategies, generalize a mathematical situation, and formulate hypotheses.

Alberta Education recommends the following two documents, which examine the open-ended question in further detail:

Assessment Alternatives in Mathematics: An overview of assessment techniques that promote learning

A Question of Thinking: A First Look at Students' Performance on Open-ended Questions in Mathematics

Both these documents are available through:

California State Department of Education
Bureau of Publications, Sales Unit
P.O. Box 271
Sacramento, CA 95802-0271

The following document was recently published by the National Council of Teachers of Mathematics. It provides some practical suggestions for the assessment of problem solving and communication on a regular basis:

Mathematics Assessment: Myths, Models, Good Questions, and Practical Suggestions

This document is available through:

National Council of Teachers of Mathematics
1906 Association Drive
Reston, VA 22091-1593

Appendix A

Calculator Policy

POLICY: USE OF CALCULATORS ON ALBERTA EDUCATION DIPLOMA EXAMINATIONS

Rationale

The knowledge, skills, and attitudes relevant to technology and its uses are being incorporated into courses and programs of study wherever appropriate. Students are expected to learn the advantages and limitations of technology developments and their impact upon society. The ability to use technology helps students understand and appreciate the process of technological change, gives added depth to programs, and provides the basis for the development of skills and understanding. These expectations are reflected in the diploma examination. Since the data provided for writing diploma examinations in mathematics and the sciences do not include information such as logarithms and trigonometric functions, students will need to use scientific calculators for these exams.

Definition

This policy considers a scientific calculator to be a hand-held device designed primarily for mathematical computations. Included in this definition are those scientific calculators having graphing capabilities, built-in formulas, mathematical functions, or other programmable features.

Policy

To ensure compatibility with provincial *Programs of Study* and equity and fairness to all students, Alberta Education expects students to use scientific calculators, as defined above, when they are writing diploma examinations in mathematics and the sciences. Examinations are constructed to ensure that the use of particular models of calculators neither advantages nor disadvantages individual students.

Procedures

1. Teachers must, at the beginning of a course, advise students of the types of calculators that they may use when writing diploma examinations in mathematics and the sciences. Teachers must also advise students of the types of information that can be stored in calculators that are brought into diploma examinations. Calculators that have built-in notes (definitions or explanations in alpha notation) that cannot be cleared are not permitted.

2. Students must clear calculators that are brought into diploma examinations of all information that they have stored except for
    a. programs used for computing values of the formulas on the diploma examination data tear-out pages or in the data booklets
    b. programs used for graphing quadratic relations as found in the Mathematics 30/33 Interim Teacher Resource Manual

3. Students must not bring external devices to support calculators into the exam. Such devices include manuals, printed or electronic cards, printers, memory expansion chips or cards, external keyboards, or any annotations outline operational procedures for scientific calculators.

4. In preparation for calculator failure, students may bring extra calculators and batteries into the exam room.

5. During exams, supervising teachers must ensure that
    a. all calculators operate in silent mode
    b. students do not share calculators or information contained within them
    c. calculator cases are stored on the floor throughout the exam
    d. all examination rules are followed

6. If you have any questions or comments about the implementation of this policy, please contact the Math/Science Unit, Student Evaluation Branch, at 403-427-0010 or FAX 403-422-4200.

Appendix B

Directing Words

Discuss
The word "discuss" will not be used as a directing word on math and science diploma examinations because it is not used consistently to mean a single activity

The following words are specific in meaning.

Compare
Show the character or relative values of two things by pointing out their *similarities* and *differences*

Conclude
State a logical end based on reasoning and/or evidence

Contrast/Distinguish
Point out the *differences* between two things that have similar or comparable natures

Criticize
Point out the *merits* and *demerits* of an item or issue

Define
Provide the essential qualities or meaning of a word or concept; make distinct and clear by marking out the limits

Describe
Give a written account or represent the characteristics of something by a figure, model, or picture

Design/Plan
Construct a plan, i.e, a detailed sequence of actions, for a specific purpose

Enumerate
Specify one by one or list in concise form and according to some order

Evaluate
Give the significance or worth of something by identifying the good and bad points or the advantages and disadvantages

Explain
Make clear what is not immediately obvious or entirely known; give the cause of or reason for; make known in detail

How
Show in what manner or way, with what meaning

Hypothesize
Form a tentative proposition intended as a possible explanation for an observed phenomenon; i.e., a possible cause for a specific effect. The proposition should be testable logically and/or empirically

Identify
Recognize and select as having the characteristics of something

Illustrate
Make clear by giving an example. The form of the example must be specified in the question; i.e., word description, sketch, or diagram

Infer
Form a generalization from sample data; arrive at a conclusion by reasoning from evidence

Interpret
Tell the meaning of something; present information in a new form that adds meaning to the original data

Justify/Show How
Show reasons for or give facts that support a position

NEW

Model
Find a model (in mathematics, a model of a situation is a pattern that is supposed to represent or set a standard for a real situation) that does a good job of representing a situation.

Outline
Give, in an organized fashion, the essential parts of something. The form of the outline must be specified in the question; i.e., lists, flow charts, concept maps

Predict
Tell in advance on the basis of empirical evidence and/or logic

Prove
Establish the truth, validity, or genuineness of something by giving factual evidence or logical reasons

Relate
Show logical or causal connection between things

Solve
Give a solution for a problem; i.e., explanation in words and/or numbers

Summarize
Give a brief account of the main points

Trace
Give a step-by-step description of the development

Why
Show the cause, reason, or purpose

Appendix C

Explanation of Mathematical Understandings

Procedures

The assessment of students' knowledge of *mathematical procedures* should provide evidence that they can:

- recognize when a procedure is appropriate
- give reasons for the steps in a procedure
- reliably and efficiently execute procedures
- verify the results of procedures empirically (e.g., using models) or analytically
- recognize correct and incorrect procedures
- generate new procedures and extend or modify familiar ones
- appreciate the nature and role of procedures in mathematics

It is important that students know how to execute mathematical procedures reliably and efficiently: a knowledge of procedures involves much more than simple execution. Students must know when to apply them, why they work, and how to verify that they have given a correct answer; they also must understand concepts underlying a procedure and the logic that justifies it. Procedural knowledge also involves the ability to differentiate those procedures that work from those that do not, and the ability to modify them or create new ones. Students must be encouraged to appreciate the nature and role of procedures in mathematics; that is, they should appreciate that procedures are created or generated as tools to meet specific needs in an efficient manner and thus can be extended or modified to fit new situations. The assessment of students' procedural knowledge, therefore, should not be limited to an evaluation of their facility in performing procedures: it should emphasize all the aspects of procedural knowledge addressed in this standard.

Concepts

The assessment of students' knowledge and understanding of *mathematical concepts* should provide evidence that they can:

- label, verbalize, and define concepts
- identify and generate examples and non-examples
- use models, diagrams, and symbols to represent concepts
- translate from one mode of representation to another
- recognize the various meanings and interpretations of concepts
- identify properties of a given concept and recognize conditions that determine a particular concept
- compare and contrast concepts

In addition, assessment should provide evidence of the extent to which students have integrated their knowledge of various concepts.

An understanding of mathematical concepts involves more than mere recall of definitions and recognition of common examples: it encompasses the broad range of abilities identified in this standard. Assessment, too, must address these aspects of conceptual understanding. Assessment tasks should focus on students' abilities to discriminate between the relevant and the irrelevant attributes of a concept in selecting examples and non-examples, to represent concepts in various ways, and to recognize students' various meanings. Tasks that ask students to apply information about a given concept in novel situations provide strong evidence of students' knowledge and understanding of that concept. Problems designed to elicit information about students' misconceptions can provide information useful in planning or modifying instruction.

Problem Solving

The assessment of students' ability to use mathematics in *solving problems* should provide evidence that they can:

- formulate problems
- apply a variety of strategies to solve problems
- solve problems
- verify and interpret results
- generalize solutions

Students' ability to solve problems develops over time as a result of extended instruction, opportunities to solve many kinds of problems, and encounters with real-world situations. Students' progress should be assessed systematically, deliberately, and continually to effectively influence their confidence and ability to solve problems in various contexts. Assessments should determine students' ability to perform all aspects of problem solving. Evidence about their ability to ask questions, use given information, and make conjectures is essential to determine if they can formulate problems. Assessments should also yield evidence of students' use of strategies and problem-solving techniques and of their ability to verify and interpret results. Finally, because the power of mathematics is derived, in part, from its generalizability, this aspect of problem solving should be assessed as well.

From *Curriculum and Evaluation Standards for School Mathematics*, National Council of Teachers of Mathematics, 1989, p. 209, p. 223, p. 228.

Appendix D

Looking at Sample Responses

This section of the bulletin will provide some samples of responses to two of the three written-response questions from the January 1997 diploma examination.

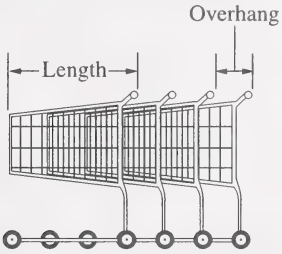
Scoring Guide for Written-Response Questions

Credit may be given to students who show unusual insight. If their solutions fall outside *specific question scoring rubrics*, they will be scored against the *General Scoring Guide* shown below.

GENERAL SCORING GUIDE	
5 marks	The student • demonstrated a *complete understanding* of the problem • used mathematical knowledge and problem-solving techniques to find the solution • justified the solution and explained its relevance to the problem
4 marks	The student • demonstrated *an understanding* of the problem • chose a strategy that used mathematical knowledge and problem-solving techniques to find a solution, but the procedure contained *a minor flaw* • showed *some justification* of his or her results
3 marks	The student • demonstrated *some understanding* of the problem • formulated *some aspects* of the problem mathematically • demonstrated the use of a strategy based on mathematical knowledge and problem-solving techniques to find a *partial* solution • communicated little understanding of the complexities of the problem
2 marks	The student • explored the *initial stages* of the problem • applied *some* relevant mathematical knowledge and problem-solving techniques to find a *partial* solution
1 mark	The student • applied some relevant mathematical knowledge to the problem

1. A grocery store manager is reviewing a design for a new grocery store. The space required to store shopping carts needs to be reviewed.

A shopping cart is 1.00 m long and 0.50 m wide. When shopping carts are "nested" together, there is a 0.25 m overhang, as shown below.



—adapted with permission from *Mathematics Teacher*, Dec., 1995 by Ann Shannon and Judith Zawojewski.

- Determine the total length of 3 shopping carts nested together.
- Determine an expression for the total length of n nested shopping carts.
- Determine the number of shopping carts nested together, if the length of the nested carts is 10.00 m.
- The store manager wants to be able to store the maximum number of nested carts possible in an open-ended rectangular shed with dimensions 8.20 m by 4.30 m. The nested carts must all be sheltered by the roof of the shed. By calculating the number of nested carts that could be stored in each of the design options, determine whether the store manager should have the design made with a short side left open or a long side left open. Justify your steps in your calculations.

Question 1—Scoring Guide	
5 marks	The student • determines space required for 3 "nested" carts • determines an expression for the length of n carts • determines that there are 37 "nested" carts in 10.00 m • determines the best shed design and communicates how this was obtained
4 marks	The student • completes all bullets but a minor error has occurred OR • completes two of the first three bullets **and** fourth bullet, all correctly
3 marks	The student • completes first three bullets correctly OR • completes fourth bullet correctly OR • completes two of the first three bullets, and attempts fourth bullet using relevant mathematical knowledge
2 marks	The student • completes one of the first three bullets correctly and attempts fourth bullet using relevant mathematical knowledge OR • correctly determines two bullets from the first three bullets
1 marks	The student • correctly answers any one of the first three bullets OR • applies some relevant mathematical knowledge to this problem

Question 1

Example 1

- **Determine the total length of 3 shopping carts nested together.**

$$1 + 0.25 + 0.25 = 1.5 \text{ m}$$

- **Determine an expression for the total length of n nested shopping carts.**

$$t_n = 1 + (n - 1)(0.25) = 0.25n + 0.75$$

- **Determine the number of shopping carts nested together, if the length of the nested carts is 10.00 m.**

$$\begin{aligned} 10.00 &= 0.25n + 0.75 \\ \frac{9.25}{0.25} &= n \\ n &= 37 \quad \text{“nested” carts} \end{aligned}$$

- **The store manager wants to be able to store the maximum number of nested carts possible in an open-ended rectangular shed with dimensions 8.20 m by 4.30 m. The nested carts must all be sheltered by the roof of the shed. By calculating the number of nested carts that could be stored in each of the design options, determine whether the store manager should have the design made with a short side left open or a long side left open. Justify your steps in your calculations.**

If the short side is left open, there is room for $\frac{4.3}{0.5}$ rows, and since the number of rows must be a natural number, there is room for 8 rows of “nested” carts. To calculate the number of carts per row, solve for n in $8.2 = 0.25n + 0.75$ where $n \in N$. There are 29 “nested” carts per row. Total number of “nested” carts is $8 \times 29 = 232$.

In the other design, the long side is left open. The number of rows is $\frac{8.2}{0.5}$, and since the number of rows must be a natural number, there are 16 rows. To calculate the number of “nested” carts per row, solve $4.3 = 0.25n + 0.75$ where $n \in N$. The value of n is 14. Total number of “nested” carts is $16 \times 14 = 224$.

To maximize the number of “nested” carts, the short side is left open.

Examples 1 and 2 would each receive a score of 5 because they demonstrate a complete understanding of the problem and have incorporated mathematical knowledge and problem-solving techniques to find the solution. The students determined the space required for three “nested” carts; an expression for t_n; that there were 37 “nested” carts in 10.00 m; and what the best shed design was. Justification for the best shed design was shown by determining the number of carts that would fit into both designs.

Question 1

Example 2

→ To determin the length of three shopping carts I will take the length of one cart and add to it the length of two overhangs.

$1.00\,m + 0.25m + 0.25m = 1.5m$

The length of three shopping carts nested together is 1.5 m.

→ An expression for the total length of n nested shopping carts could be

Length of n shopping carts $= 1.00m + [0.25m \times (n-1)]$

→ $10.00 = 1.00 + [0.25 \times (n-1)]$

$10.00 - 1.00 = 0.25 \times (n-1)$

$9.00 = 0.25 \times (n-1)$

$\frac{9.00m}{0.25m} = n-1$

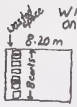
$36 = n-1$

$n = 37$

The number of carts needed when nested together to reach 10.00m is 37

To start I will calculate how many carts can fit in the width of the shed, Assuming he leaves the short side open.

$\frac{4.30m}{.5m} = 8.6$ carts across



However 8.6 carts is not a reasonable answer because he cannot put ⅙ of a cart in so he can only put in 8 carts but will waste ⅙ of a cart in space.

For the length he will have to leave .20m at the end in order to shelter the carts.

$8m = 1.00m + [.25 \times (n-1)]$

$7 = .25 \times n-1$

$28 = n-1$

$n = 29$ carts

For the length he can fit in 29 carts and so

$29 \times 8 = 232$ carts

He can fit 232 carts if he leaves the short end open.

For leaving the long side open he can fit:

$\frac{8.20m}{.5m} = 16.4$ carts across

Again he cannot fit in ¼ of a cart so the total number of carts he can fit across is 16.

For the length he will have to leave only 0.5 m in order to shelter his carts so $4.25m = 1.00m + [.25 \times (n-1)]$

$3.25 = .25 \times (n-1)$

$13 = n-1$

$n = 14$ carts

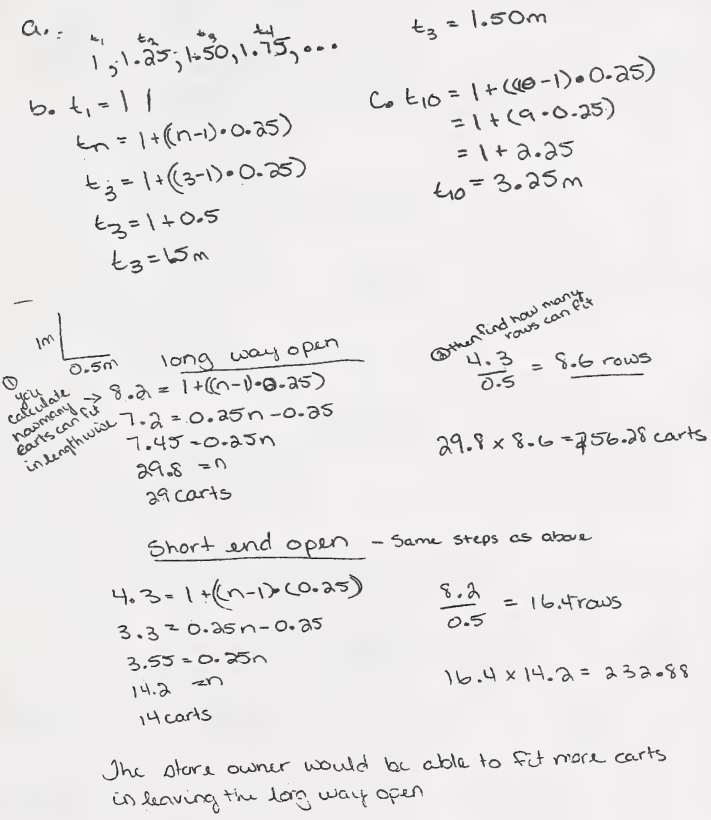
he can fit 14 carts in the end so $14 \times 16 = 224$ carts in all.

$232 - 224 = 8$

He will be able to fit 8 more carts in if he leaves the short end open so leaving the short end open is the better choice.

Question 1

Example 3


a.
t_1 t_2 t_3 t_4
1, 1.25, 1.50, 1.75, ...
$t_3 = 1.50\text{m}$
b. $t_1 = 1$ | 1
$t_n = 1 + ((n-1) \cdot 0.25)$
$t_3 = 1 + ((3-1) \cdot 0.25)$
$t_3 = 1 + 0.5$
$t_3 = 1.5\text{m}$
c. $t_{10} = 1 + ((10-1) \cdot 0.25)$
$= 1 + (9 \cdot 0.25)$
$= 1 + 2.25$
$t_{10} = 3.25\text{m}$
1m
0.5m
long way open
① you calculate how many carts can fit in length wise
$8.2 = 1 + ((n-1) \cdot 0.25)$
$7.2 = 0.25n - 0.25$
$7.45 = 0.25n$
$29.8 = n$
29 carts
② then find how many rows can fit
$\frac{4.3}{0.5} = 8.6$ rows
$29.8 \times 8.6 = 256.28$ carts
short end open - same steps as above
$4.3 = 1 + ((n-1) \times (0.25))$
$3.3 = 0.25n - 0.25$
$3.55 = 0.25n$
$14.2 = n$
14 carts
$\frac{8.2}{0.5} = 16.4$ rows
$16.4 \times 14.2 = 232.88$
The store owner would be able to fit more carts in leaving the long way open

This response would receive a score of 3. It showed a correct calculation for the length of three shopping carts "nested" together (i.e., 1.5 m) and a simplified expression for the total length, t_n, of n nested shopping carts. Although there was an attempt to determine the best shed design, it was incomplete and the number of nested shopping carts in 10.00 m was not determined.

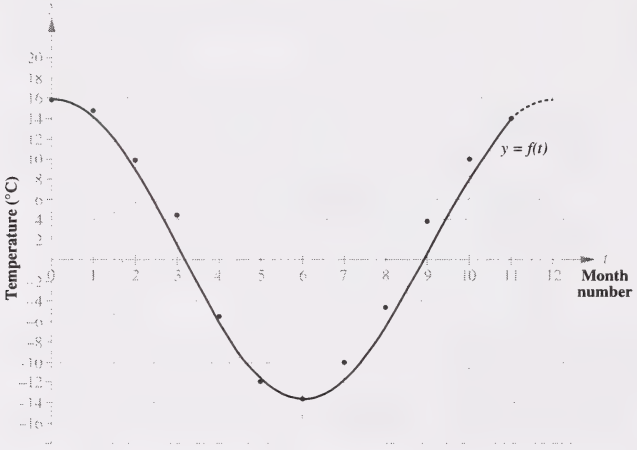
Written Response — 10%

3. The table below gives the monthly **mean** temperature recorded over a 30-year period in Red Deer, Alberta.

Month	Month Number	Temp. (° C)
July	0	15.8
Aug	1	15.0
Sept	2	9.9
Oct	3	4.6
Nov	4	–5.3
Dec	5	–11.9

Month	Month Number	Temp. (° C)
Jan	6	–13.5
Feb	7	–10.0
Mar	8	–4.7
Apr	9	3.7
May	10	9.9
June	11	14.0

The graph of a sinusoidal function, f, with maximum value 15.8 in July, and minimum value –13.5 in January, was compared with the measured data.



—from *Canadian Climate Normals*, 1961–1990, v.2, *Prairie Provinces*, Environment Canada

- Determine the amplitude and the period of the sinusoidal function.

- Determine an equation of the sinusoidal function, f, in the figure. Write the equation in the form $y = a \cos bt + d$.

- Assume that temperatures over the next 30 years will again be modelled by a sinusoidal function with the same period. If the monthly mean temperatures have all risen as a result of global warming, what changes, if any, would you predict to the amplitude and vertical displacement of the sinusoidal function? (These predictions are independent of each other.) Explain your predictions.

Question 3—Scoring Guide	
5 marks	The student • determines the amplitude, period, and equation, and clearly explains the predicted effects of global warming on amplitude and vertical displacement
4 marks	The student • completes all bullets, but a minor error or omission has occurred
3 marks	The student • determines the amplitude, period, and equation, but makes no predictions regarding global warming OR • determines the amplitude **or** period of f **and** explains the predicted effects of global warming on amplitude and vertical displacement OR • determines the amplitude and period, and gives an explanation for global warming, with a minor omission OR • determines the amplitude or period, and gives a **complete** equation consistent with the amplitude and period, as well as an explanation for global warming, with a minor omission
2 marks	The student • determines the amplitude or period and offers a partial solution for the other parts of the problem OR • explores the initial stages of the first two parts of the problem and provides two correct predictions for global warming OR • gives a correct equation OR • gives a complete explanation for global warming
1 mark	The student • determines a reasonable value for one parameter or gives a partially correct equation OR • makes a meaningful comment regarding the predicted effects of global warming on future graphs

Question 3

Example 1

- **Determine the amplitude and the period of the sinusoidal function.**

  The amplitude is $\frac{1}{2}(15.8 + 13.5) = 14.65$

  The minimum positive period is 12 months.

- **Determine an equation of the sinusoidal function, f, in the figure. Write the equation in the form $y = a \cos bt + d$.**

$$a = 14.65$$
$$b = \frac{2\pi}{12} = \frac{\pi}{6}$$
$$d = 15.8 - 14.65$$
$$= 1.15$$
$$y = 14.65 \cos\left(\frac{\pi}{6}t\right) + 1.15$$

- **Assume that temperatures over the next 30 years will again be modelled by a sinusoidal function with the same period. If the monthly mean temperatures have all risen as a result of global warming, what changes, if any, would you predict to the amplitude and vertical displacement of the sinusoidal function? (These predictions are independent of each other.) Explain your predictions.**

If **all** the mean monthly temperatures rise by approximately the **same amount**, $k°$, the amplitude of a future graph would not change. However, the vertical displacement would become $1.15 + k$.

Examples 1 and 2 would each receive a score of 5. Both responses clearly show the correct calculated values for the amplitude and period of the given sinusoidal function. The equation of the function, f, is written in the form $y = a \cos bt + d$, and the predicted effects of global warming on amplitude and vertical displacement are clearly explained.

Question 3

Example 2

① Amplitude is determined by dividing the total range by 2.
ie. (maximum − minimum) ÷ 2

total range → $\frac{15.8-(-13.5)}{2} = \frac{29.3}{2} = 14.65$

The amplitude of the sinusoidal function is 14.65

The period is determined by picking any point on the graph & finding the next consecutive point at which the graph reaches the same pt. of commencement.
The period is $\boxed{12}$ (Period may also be found using the formula $\frac{2\pi}{b}$)

② $y = a \cos bt + d$
a = amplitude = 14.65
d = vertical shift = 1.15
$b = \frac{2\pi}{12} = 0.52$ $\qquad y = 14.65 \cos(0.52t) + 1.15$

③ Assuming that the temperatures over the next 30 years will again be modelled by the same sinusoidal function with the same period. If all the monthly mean temperatures have risen uniformly, I would predict a change in vertical displacement but no change in amplitude.
This is so because since all the mean temperatures increase by the same amount the maximum and the minimum would be relative to the original sinusoidal function 30 years in the past. Therefore the formula of max − min for amplitude would yield the same amplitude of 14.65. If the temperatures do not increase uniformly there would be a difference in amplitude because the maximum might stretch further than its relative value, and/or the minimum may also do the same.
If all the temperatures increase uniformly, the graph would shift up in its relative value. If all temperatures increased by 5°C, then the line of symmetry would also increase by 5. If the amplitude changes so will the vertical shift.

Question 3

Example 3

- amplitude $\frac{15.8 + 13.5}{2} = 14.65\,^{\circ}C$

  period 12 months

- $y = a\cos bt + d$

  $y = 14.65 \cos 12t + 1.15$

- I predict that the amplitude would remain unchanged. The rise in temperature would affect all points on the graph. If, for example, the highest temperature on the graph rose 2°C so would the lowest temperature and all points in between.

  The vertical displacement, however, would increase as all the temperatures increase. The graph will retain its shape but begin moving upwards.

This response would receive a score of 4. It shows a common minor error where the value of the period is used as the coefficient of *t*. Otherwise, the response is correct.

Question 3

Example 4

- $A = \frac{M-m}{2}$ Amplitude = $\frac{\text{maximum value} - \text{minimum value}}{2}$

$A = \frac{15.8+(13.5)}{2}$

$A = \frac{29.3}{2}$

$A = 14.65$

Period = $\frac{2\pi}{b} = \frac{2\pi}{b} = \frac{11}{1} = \boxed{\frac{2\pi}{11}}$

- $y = 14.65 \cos\left(b - \frac{2\pi}{11}\right)$

$y = 14.65 \cos\left(b + \frac{2\pi}{11}\right)$

- The amplitude would stay very similar because the warm temperatures will get warmer, but the cool temperatures will also increase. ∴ the veritcal displacement would be upwards because each temperature will increase (each point will be higher up on the graph).

→ they will rise together but stay the same distance apart.

This response would receive a score of 2. The response shows a correct calculation for the value of the amplitude but an incorrect calculation for the value of the period and an incorrect equation to represent the given sinusoidal function. The explanation for the predicted changes in the function due to global warming is weak.

Appendix E

Mathematics 30 Curriculum Standards

Mathematics 30 Curriculum Standards

The Curriculum Standards provided in this appendix are intended to clarify the Mathematics 30 Course of Studies *statements. Included are some examples of questions that students must be able to do to demonstrate* acceptable *or* excellent *achievement. For a definition of* acceptable *and* excellent *achievement, see page 10 of this bulletin.*

Note: For the complete documentation of Mathematics 30 Learner Expectations, please refer to the Mathematics 30 Course of Studies.

Problem Solving

Students in Mathematics 30 can participate in and contribute toward the problem-solving process for problems within the seven content strands.[1]

Examples

- Given the solution to a problem, analyze the solution for correctness, provide the correct response, and provide possible reasons for errors. For example:

  Menghsha examined the graph of the function $y = 3 \sin \theta$ and determined that the domain of the function was $-1 \leq \theta \leq 1$. Is Menghsha's answer correct? If not, provide the correct answer and explain Menghsha's error.

- Given one method of solving a problem, solve it a second way. For example:

  Jillian was asked to find the factors of $P(x) = x^3 - 9x^2 - x + 9$. On her graphing calculator, she graphed the function and determined that the factors for $P(x)$ were $(x - 9)$, $(x + 1)$, and $(x - 1)$. If Jillian was unable to graph $P(x)$, show another method that Jillian could have used to find its factors.

- Given that a ferris wheel with a radius of 18 m makes a complete revolution in 12 s, draw a diagram of the situation and create a table of values showing the relationship between the height h of a rider above the ground (the lowest point of the ferris wheel is 1 m above the ground) and the time t to determine the height of a rider after 6 s.

- Given a problem, solve it for the specific case(s) and then provide a general solution. For example:

  Given a 4-sided and a 10-sided polygon, determine the number of diagonals in each. Also determine a general statement about the number of diagonals in an n-sided polygon.

- Given that a ferris wheel with a radius of 18 m makes a complete revolution in 12 s, develop a mathematical model that describes the relationship between the height h of a rider above the lowest point of the ferris wheel, which is 1 m above the ground, and the time t. Provide a full explanation of how your model was developed and suggest alternative ways of developing the model.

[1] Italicized comments give an overview of the curriculum statements to be found in the *Mathematics 30 Course of Studies.*

Polynomial Functions

Acceptable Standard The student can	*Excellent Standard* The student can also
• recognize and give examples of polynomial functions of different degrees	
• generate the graph of any integral polynomial function with the use of graphing calculators or graphing utility packages	
• use the Remainder Theorem to evaluate a third-degree integral polynomial function for rational values of the variable and to understand how this can be used to find factors of the polynomial function	• use the Remainder Theorem when either the factor or the original polynomial contains unknown coefficients • use the Remainder Theorem to evaluate integral polynomial function beyond the third degree for rational values of the variable, and understand how this can be used to find factors of the polynomial function
• factor and find the zeros for an integral polynomial function in standard form, degree 3 or less, in which all zeros are rational	
• by using graphing calculators or computers, find approximations for all the real zeros of integral polynomial functions	
• derive an equation of an integral third-degree polynomial function, given its rational zeros	• derive an equation for an integral polynomial function, given its zeros and any other information that will uniquely define it
• recognize the general shape of graphs of integral polynomial functions of degree four or less where the multiplicity of zeros is one, two, or three	• recognize the general shape of graphs of integral polynomial functions of degree n where the multiplicity of zeros is greater than two • explain the relationships between the graphs of different polynomial functions and their zeros

- identify the potential rational zeros of an integral polynomial function
- determine the minimum degree of a polynomial function by using the multiplicities of its zeros
- participate in and contribute toward the problem-solving process for problems that can be represented by polynomial functions studied in Mathematics 30
- complete the solution to problems that can be represented by polynomial functions studied in Mathematics 30

Examples

- Given $P(x) = 10x^3 + 51x^2 + 3x - 10$, determine its zeros, its factors, and its graph. The student can also describe the relationship among its zeros, its factors, and its graph.
- Given $P(x) = ax^3 + bx^2 + 3$ and that the remainders are 7 and 10 when divided by $x - 2$ and $x + 1$ respectively, determine the zeros, the factors, and the graph of $P(x)$.

Trigonometric and Circular Functions

Acceptable Standard The student can	*Excellent Standard* The student can also
• convert angle measurements between degree and radian measure	
• given any two of the following measurements—the radian measure of the central angle, the radius, or the length of an arc—determine the unknown measurement	
• verify[2] the fundamental trigonometric identities	• prove[3] trigonometric identities
• solve first-degree trigonometric equations on the domain $0 \leq \theta < 2\pi$ in radians and $0° \leq \theta < 360°$	• solve first- and second-degree trigonometric equations, including double and half angles on the domain $0 \leq \theta < 2\pi$ and $0° \leq \theta < 360°$
• simplify and evaluate simple trigonometric expressions involving the fundamental trigonometric identities	
• generate the graph of trigonometric functions with the use of graphing calculators or graphing utility packages	
• explain the effect of each parameter a, b, c, and d on the graph of the $y = a \sin[b(\theta + c)] + d$ and $y = a \cos[b(\theta + c)] + d$ functions	• explain, orally and in writing, the combined effects of the parameters a, b, c, and d in the trigonometric functions $y = a \sin[b(\theta + c)] + d$ and $y = a \cos[b(\theta + c)] + d$, on the functions' domain and range
• state the domain and range of $y = \sin\theta$, $y = \cos\theta$, and $y = \tan\theta$	

[2]For a definition of **verify**, see the *Mathematics 30 Course of Studies*, p. 6.

[3]For a definition of **prove,** see the *Mathematics 30 Course of Studies*, p. 6.

- describe, orally and in writing, the relationship between the root(s) of a first-degree trigonometric equation and the graph of its corresponding function
- participate in and contribute toward the problem-solving process for problems that can be represented by trigonometric functions studied in Mathematics 30

- describe, orally and in writing, the relationship between the root(s) of a trigonometric equation and the graph of its corresponding function
- complete the solution to problems that can be represented by trigonometric functions studied in Mathematics 30

Examples

- Given $y = 2\sin\left(\theta - \frac{1}{2}\right)$, $0 \le \theta < 2\pi$, determine its zeros, describe orally and in writing the relationship between its zeros and its corresponding graph, and describe the effect that 2 and $-\frac{1}{2}$ have on the graph of $y = \sin\theta$.
- Given $\frac{\cot\theta}{\tan\theta}$, use fundamental trigonometric identities to simplify the expression and verify this simplification by substituting values for the variable and by comparing their corresponding graphs.

- Given $2 - 2\cos^2\theta = \sin\theta$, $0 \le \theta < 2\pi$, determine its zeros and describe, orally and in writing, the relationship between its zeros and the graphs of $y = 2 - 2\cos^2\theta$ and $y = \sin\theta$.

Statistics

Acceptable Standard The student can	*Excellent Standard* The student can also
• describe the characteristics of normally distributed data	
• interpret the mean and standard deviation of a set of normally distributed data	
• apply the standard normal curve and the z-scores of data that are normally distributed	
• participate in and contribute toward the problem-solving process for problems that require the analysis of statistics studied in Mathematics 30	• complete the solution to problems that require the analysis of statistics studied in Mathematics 30

Examples

• Given that the results of a test were normally distributed with a mean of 30 and a standard deviation of 5, and given that the passing mark was set at 25, determine the percentage of students who passed the test.	• Given that the results of a test were normally distributed with a mean of 30 and a standard deviation of 5, and given that the passing mark was set at 25, determine the percentage of students who passed the test.

Quadratic Relations

Acceptable Standard The student can	*Excellent Standard* The student can also
• describe orally, in writing, and by modelling, the intersection of a plane and a conical surface that would result in a hyperbola, an ellipse, a parabola, and a circle	
• describe orally, in writing, and by modelling, and identify the position of the plane at which the intersection of a plane and a conical surface defines a degenerate ellipse and hyperbola	• describe orally, in writing, and by modelling, and identify the position of the plane at which the intersection of a plane and a conical surface defines a degenerate parabola
• generate the graph of quadratic relations with the use of graphing calculators or graphing utility packages	
• describe, orally and in writing, and identify the quadratic relation defined by a combination of numerical coefficients for any quadratic relation in the form $Ax^2 + Bxy + Cy^2 + Dx + Ey + F = 0$, where $B = 0$	
• describe, orally and in writing, and identify the quadratic relation formed when given the value of the eccentricity	
• describe, orally and in writing, and identify the eccentricity when given the quadratic relation	• describe, orally and in writing, the combination of values for the numerical coefficients of the general quadratic relation $Ax^2 + Bxy + Cy^2 + Dx + Ey + F = 0$, where $B = 0$, that would result in the degenerate conics
• describe, orally and in writing, and identify the quadratic relation formed when given the locus definition	• describe, orally and in writing, and identify the changes in the graph of a quadratic relation when the eccentricity changes

• identify and graph the quadratic relation when given a point on the quadratic relation, a fixed point, and the eccentricity	
• calculate the eccentricity when given a fixed horizontal or vertical line, a fixed point, and a point on the quadratic relation	• use the locus definition to verify the equation of each conic section
• identify and graph the quadratic relation when given the eccentricity, a fixed point, and a fixed horizontal or vertical line	
• describe, orally and in writing, and identify the effects on the graph of the quadratic relation in the form $Ax^2 + Bxy + Cy^2 + Dx + Ey + F = 0$, where $B = 0$, when **two** of the numerical coefficients change	• describe, orally and in writing, and identify the effects on the graph of the quadratic relation in the form $Ax^2 + Bxy + Cy^2 + Dx + Ey + F = 0$, where $B = 0$, when two or more of the numerical coefficients change
• participate in and contribute toward the problem-solving process for problems that require the analysis of quadratic relations studied in Mathematics 30	• complete the solution to problems that require the analysis of quadratic relations studied in Mathematics 30

Examples

- Given $2x^2 + 2y^2 + x - 3y - 25 = 0$, identify the quadratic relation described by this equation.

- Given $Ax^2 + Cy^2 + Dx - Ey - 36 = 0$, identify this as a hyperbola when $AC < 0$.

- Given that a quadratic relation is represented by $3x^2 + 4y^2 + 5x + Ey - 36 = 0$, where $B = 0$, describe, orally or in writing, what happens to the graph of this quadratic relation when 5 is changed to –4 and –36 is changed to –9.

- Given a quadratic relation that is described as having an eccentricity of 2, identify this as a hyperbola and describe its locus.

- Given a locus of points such that the sum of the distances between one of the points and two fixed points is constant, identify this locus as an ellipse.

- Given a description of the intersection of a plane and a conical surface, identify the conic section formed.

- Given that the cutting plane approaches the vertex of the conical surface, describe orally, in writing, and by modelling, the effect on the ellipse.

- Given that the eccentricity of the orbit of Halley's comet, which has a period of 76 years, is 0.96, sketch its graph.

- Describe and identify the effects on the graph of the quadratic relation in the form

  $Ax^2 + Bxy + Cy^2 + Dx + Ey + F = 0$, where $B = 0$, when two or more of the numerical coefficients change.

- Given a description of the intersection of a plane and a conical surface, identify orally or in writing the degenerate parabola formed.

- Given the equation of a degenerate quadratic relation in the form $Ax^2 + Bxy + Cy^2 + Dx + Ey + F = 0$, where $B = 0$, describe, orally and in writing, the quadratic relation formed.

- Given the graph and the eccentricity of a quadratic relation, describe, orally and in writing, the changes to the graph when the eccentricity changes.

- Given that the fixed point of an ellipse is moving closer to the centre of the ellipse, describe, orally and in writing, the effect on the eccentricity.

- Given that the eccentricity of any quadratic relation is the ratio of the distance between any point and a fixed point to the distance between the same point and a fixed line, describe, orally and in writing, the effect that changing the eccentricity has on the relative positions of the fixed line and the fixed point.

Exponential and Logarithmic Functions

Acceptable Standard The student can	*Excellent Standard* The student can also
• generate the graph of exponential and logarithmic functions with the use of graphing calculators or graphing utility packages	
• recognize and sketch the graphs of exponential and logarithmic functions and recognize their inverse relationship	
• convert functions from exponential form to logarithmic form and vice versa	
• apply the laws and properties of logarithms to evaluate logarithmic expressions	
• solve and verify simple exponential and logarithmic equations	• solve and verify exponential and logarithmic equations
• state the domain and range of the exponential and logarithmic functions	
• use the graphs of the exponential and logarithmic functions to estimate the value of one of the variables, given the other variable	
• participate in and contribute toward the problem-solving process for problems that can be represented by logarithmic or exponential functions studied in Mathematics 30	• complete the solution to problems that can be represented by logarithmic or exponential functions studied in Mathematics 30

Examples

- Given $f(x) = 4^{2x}$, sketch its graph, describe its domain and range, find the zeros of its corresponding equation, and describe orally and in writing the relationship between the roots of its equation and its graph. The student can write the inverse of $f(x) = 4^{2x}$ in logarithmic form, sketch its graph, describe its domain and range, determine the zeros of this equation, and describe orally and in writing the relationship between the zeros of its equation and its graph.

- Given the equation $\log_5(x-4) + \log_5(x-2) = 3$, find all the possible values of x, identify the domain, describe orally and in writing the relationship between the roots of this equation and its graph, and describe orally and in writing the reasons why there are values of x that satisfy the equation but that are not permissible for the function.

Permutations and Combinations

Acceptable Standard The student can	*Excellent Standard* The student can also
• calculate the number of linear, circle, and ring permutations and permutations with repetitions of n things taken r at a time	• explain the reason that there are different numbers of permutations when a given number of objects are arranged in a line, a circle, or a ring, or when some of the objects are repeated or identical
• calculate the number of combinations of n things taken r at a time	
• expand binomials of the form $(x + a)^n$, $n \in W$, using the Binomial Theorem	• expand binomials of the form $(x + by)^n$, $n \in W$, using the Binomial Theorem, and determine specific terms of this expansion
• describe, orally and in writing, the difference between a permutation and a combination	
• participate in and contribute toward the problem-solving process for problems involving permutations and/or combinations, including probability problems, studied in Mathematics 30	• complete the solution to problems involving permutations and/or combinations, including probability problems, studied in Mathematics 30

Examples

- Given that there are 10 musicians in the finals of a music competition, decide whether permutations or combinations should be used to calculate the number of ways in which first, second, and third prizes can be awarded.

- Given the binomial $(x + 2)^5$, find the coefficient of the x^3 term in the expansion, determine how the coefficient of the term containing $x^4(2)$ is obtained, determine the number of terms in the expansion of $(x + 2)^5$, and describe orally and in writing the relationship between the number of terms in the expansion and the exponent of the binomial.

- Given that five people can sit at a round table, decide whether permutations or combinations should be used to determine the number of different orders in which these five can sit at the table if Jack and Jill must sit next to one another. Justify the method of solution.

- Given the binomial $(3x - 2y)^7$, find the coefficient of the x^3 term in the expansion, determine how the coefficient of the term containing $[(3x)^6(2y)]$ is obtained, and determine the number of terms in the expansion of $(3x - 2y)^7$. Describe, orally and in writing, the relationship between the number of terms in the expansion and the exponent of the binomial, how the number of a given term in the expansion of $(3x - 2y)^7$ relates to the exponent of $(2y)$ in that term, and how the coefficients of the terms that are equidistant from the ends of the expansion of $(3x - 2y)^7$ compare in terms of combinations.

Sequences and Series

Acceptable Standard The student can	*Excellent Standard* The student can also
• write the specific terms of a sequence, given its defining function	• write the specific terms of a sequence when given its recursive definition • determine the functions describing any sequence that has a recognizable pattern
• expand a series given in sigma notation	
• describe, orally and in writing, the difference between sequences and series, arithmetic or geometric, infinite and finite	
• apply the general term "formula" to arithmetic and geometric sequences	• solve problems using the general term and/or sum formulas in which there are two unknowns
• apply the sum formula for arithmetic and geometric series	
• participate in and contribute toward the problem-solving process for problems involving sum and term formulas for arithmetic and geometric series and sequences studied in Mathematics 30	• complete the solution to problems involving sum and term formulas for arithmetic and geometric series and sequences studied in Mathematics 30

Examples

- Given that a sequence is defined by $t_n = 5n - 3$, write the terms of the sequence, determine whether the sequence is arithmetic or geometric, determine the common difference or common ratio, determine the related series, and determine the sum of a specified number of terms.
- Given that a series is defined by $\sum_{n=3}^{6}(-2)^n$, write the terms of the series, determine whether the series is arithmetic or geometric, and determine the sum of the series.

- Given that a sequence is defined by $t_n = 5n - 3$, write the terms of the sequence, determine whether the sequence is arithmetic or geometric, determine the common difference or common ratio, determine the related series, determine the sum of a specified number of terms, and determine the formula for the sum of n terms.
- Given an arithmetic sequence where $t_4 + t_{13} = 99$ and $t_7 = 39$, determine the first term of this sequence.

National Library of Canada
Bibliothèque nationale du Canada
3 3286 51377 2869

Mathematics 30 Information Bulletin